Title**: Carbon Sequestration in Himalaya's Alpine Meadows**
Sub-title: **Mitigating Cropping Encroachment on Pastures in Northern Pakistan**

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Rangelands store about 30% of the world's carbon and support over 120 million pastoralists globally. Adjusting the management of remote alpine pastures bears a substantial climate change mitigation potential that can provide livelihood support for marginalized pastoralists through carbon payment. Landless pastoralists in Northern Pakistan seek higher income by cropping potatoes and peas over alpine pastures. However, tilling steep slopes without terracing exposes soil to erosion. Moreover, yields decline rapidly requiring increasing fertilizer inputs. Under these conditions, carbon payment could be a feasible option to compensate pastoralists for renouncing hazardous cropping while favoring pastoral activities. The study quantifies and compares C on cropped and grazed land. The hypothesis was that cropping on alpine pastures reduces former carbon storage. The study area located in the Naran valley of the Pakistani Himalayas receives an annual average of 819 mm of rain and 764 mm of snow. Average temperatures remain below 0°C from November to March while frost may occur all year round. A total of 72 soil core samples were collected discriminating land use (cropping, pasture), aspect (North, South), elevation (low 3000, middle 3100, and high 3200 m a.s.l.), and soil depth (shallow 0-10, deep 10-30 cm). Thirty six biomass samples were collected over the same independent variables (except for soil depth) using a 10x10x20 cm steal box inserted in the ground for each sample. Aboveground biomass and coarse roots were separated from the soil aggregate and oven-dried. Soil organic carbon (SOC) and biomass carbon (BC) were estimated through a potassium dichromate oxidation treatment. The samples were collected during the second week of October 2010 at the end of the grazing and cropping season and before the first snowfall. The data was statistically analyzed by means of a one-way analysis of variance. Results show that all variables taken separately have a significant effect on mean SOC [%]: crop/pasture 1.33/1.6, North/South 1.61/1.32, low/middle/high 1.09/1.62/1.68, shallow/deep 1.4/1.53. However, for BC, only land use has a significant effect with more than twice the amount of carbon in pastures [g m^{-2}]: crop/pasture 127/318. These preliminary findings suggest that preventing the conversion of pastures into cropping fields in the Naran valley avoids

an average loss of 12.2 t C ha^{-1} or 44.8 t CO_2eq ha^{-1} representing a foreseeable compensation of 672 € ha^{-1} for the Naran landless pastoralists who would renounce cropping. The ongoing study shall provide a complete picture for carbon payment integrating key aspects such as the rate of cropping encroachment over pastures per year, the methane leakage from the system due to livestock enteric fermentation, the expected cropping income vs. livestock income and the transaction costs of implementing the mitigation project, certifying it, and verifying carbon credits. A net present value over an infinite time horizon for the mitigation scenario shall be estimated on an iterative simulation to consider weather and price uncertainties. The study will also provide an estimate of the minimum price of carbon at which pastoralists would consider engaging in the mitigation activity.

Type of contribution:
First choice is an oral presentation. If this should not be feasible, a poster will be produced.

Confirmation:
This first hand empiric material belongs genuinely to the authors who have developed the research concept, designed the experiment, collected the data, conducted the lab work, and analyzed the data. Funding for this research was partly provided by the Landless Pastoralist Research Project (LPRP) and the NCCR North-South TN3RP15. Only the institutions indicated in the affiliations of the authors have a claim over this research.